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Differences in Participation and Performance Trends in Age Group Half and Full Marathoners

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Abstract

Recent studies investigated participation and performance trends in age group half marathoners and full marathoners for a single event. The present study investigated participation and performance trends in age group athletes in all half marathons and full marathons held in a single country during a given period of time. Changes in running performance and age of 226,754 half marathoners and 86,419 full marathoners competing in Switzerland between 2000 and 2010 were analyzed using linear regression analyses. The number of half marathoners increased ($P < 0.01$) from 2000 to 2010 for both men (+231%) and women (+299%). In contrast, the number of male and female full marathoners increased until 2005 only and decreased thereafter. The greatest part of the finishers of both genders was assigned to age group 40-44 years in half marathons (19.5% of finishers) and full marathons (22.0% of finishers). Running performance of female full marathoners improved in age groups 30-34, 35-39, 40-44, 45-49 and 50-54 years. Running performance of male full marathoners improved in age groups 25-29, 30-34, 35-39, 45-49 and 55-59 years. Female half marathoners achieved no change in running times in all age groups. For male half marathoners in age groups 30-34, 40-44 and 50-54 years, running performance declined. In conclusion, during the 2000-2010 period in Switzerland, it appeared that participation in half marathons increased but running performance stabilized. In contrast, participation in full marathons decreased but running performance improved. Further investigations are required to collect complete data for other countries and the investigation of other endurance events in Switzerland.

Key Words: master athlete, performance, running, Swiss athlete

Introduction

In the last decades a continuous increase in the number of participants in long-distance running events such as marathons was reported (6, www.runningusa.org/statistics). Due to this great worldwide popularity, marathon running can be used as a model for analyzing trends of participation and performance in different age groups during a longer period beside other running disciplines (16, 21).

In recent years, half marathon running enjoyed a greater popularity than full marathon running according to participation trends of long-distance runners in the USA (www.runningusa.org/statistics). A continuous increase in the number of half marathoners was recorded in the USA since 1990. The highest number was reached in 2011 with a total of 1,600,000 starters corresponding to an increase of

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16.2% runners compared to the year before. This increase was less than the historic ones of 24% in both 2008 and 2009, but still higher than in 2010 with an increase in 6.4%. In the past years, the number of full marathoners in the USA increased only slightly in contrast to half marathoners. When in 2009 an increase of 9.9% and in 2010 an increase of 8.9% was noted, the number of full marathoners only rose by 2.2% from 2010 to 2011. In contrast to the USA, the number of full marathoners in a European country such as Germany continuously increased until 2006, with a slow decrease thereafter (www.marathon-bestenliste.de). No data are available yet for half marathoners as a survey for Germany was only started in 2012.

Regarding different age groups in a popular city marathon such as the 'New York City Marathon' a change in participation trends was reported (16, 21). In 2011, more than one third of all full marathoners in the USA were older than 40 years, in half marathons the part of this age group rose to 40% (www.runningusa.org/statistics). The increase of full marathoners and half marathoners in the USA is most probably due to a higher number of runners older than 40 years and an increase in female runners (www.runningusa.org/statistics). Similarly, in Germany, the number of male and female full marathoners in age group 50-59 years was almost 10% higher than in age group 20-29 years (23).

Two studies investigating performance trends in the 'New York City Marathon' showed that especially older runners improved running times across years (16, 21). Between 1983 and 1999, a higher number of male and female runners older than 50 years participated in the 'New York City Marathon' (16). Women between 40 and 69 years and men between 50 and 79 years improved running times across years whereas this development was not seen for athletes in other age groups (16). Both Jokl *et al*. (16) and Lepers and Cattagni (21) focused on analyzing participation and performance trends in age group athletes competing in the 'New York City Marathon' in the last 30 years. During this time, a significant reduction of running times was shown for men older than 64 years and women older than 44 years (21). For German marathons, Leyk *et al*. (23) reported a decline of performances after the age of 50 years, which could not be explained by the progressing biological ageing but rather by a passive and unhealthy way of life (13, 22, 23, 32). It has been shown that regular endurance training and an adequate way of life is a precondition for successfully finishing a marathon (31). Furthermore, Leyk *et al*. (23) showed that a great part of athletes had started running after reaching an age of 40 years. In comparison, similar findings for half marathoners are not yet available.

Previous studies on half marathons, full marathons and ultra marathons investigated a potential association between both physiological and anthropometric characteristics and performance (27, 35). Zillmann *et al*. (35) found an association between training and anthropometric characteristics and race time for recreational male half and full marathoners. Furthermore, the percent body fat and speed in running during training were related to race time. Rüst *et al*. (27) showed for ultra-marathoners that percent body fat was positively related to 100 km race times whereas weekly running kilometers were negatively related.

Recent investigations focused on a single full marathon event (16, 21) or considered a limited sample of full marathons held within one country (22, 23). The analysis of a single full marathon race or a sample of full marathon races might not be representative for the participation and performance trends in age group athletes, because only a certain sample of athletes might take part in a popular event like the 'New York City Marathon'. This might thus not be representative for the fitness behavior of the general population of a whole country. Therefore, the aim of the present study was to analyze participation and performance trends in age groups athletes for all full marathons and half marathons held in one country (Switzerland) between 2000 and 2010. As recorded for the USA, we assumed an increase in half marathoners but we suspected that the number of full marathoners would not increase within this time period. In contrast, we hypothesized a similar decline in participation in full marathons as recorded for the northern neighboring country Germany. For Switzerland, we expected that more athletes would finish in a half marathon whereas the number of full marathoners might even decline. Presumably, there would be an increase of the number of participants in age groups older than 40 years during this period as well as an improvement of the performances in these age groups for both full and half marathons.

Materials and Methods

Ethics

All procedures used in the study met the ethical standards of the Swiss Academy of Medical Sciences and were approved by the Institutional Review Board of Kanton St. Gallen, Switzerland, with a waiver of the requirement for informed consent of the participants given the fact that the study involved the analysis of publicly available data.

Data Sampling and Data Analysis

All runners who finished a full or a half marathon

Table 1. Number of finishers in Swiss half marathons and full marathons sorted by gender for a mean annual number of six half marathons and three full marathons from 2000 to 2010

Total Athletes	313,173
Marathon	86,419
Men	71,383
Women	15,036
Half Marathon	226,754
Men	162,457
Women	64,297

in Switzerland between 2000 and 2010 were analyzed regarding participation and performance trends. The data set for this study was obtained from www.datasport.ch and the race directors. Table 1 presents the number of finishers in Swiss half and full marathons sorted by gender. For the analysis of performance, seven male half marathoners had to be excluded due to the lack of information about race time. Additionally, out of a total of 186 female half marathoners and 373 male half marathoners, no information regarding age was given for 29 female and 120 male full marathoners. These athletes were excluded from data analysis.

Firstly, the change of the annual number of male and female finishers in half and full marathons was determined. To find trends in the change of the top performance, all full and half marathons held in the same year were pooled. From all half and all full marathons, the annual top five (*e.g.* finishers the five fastest running times) women and men were determined. To find changes in participation and performance over time in age groups, all athletes were categorized into age groups 20-24, 25-29, 30-34, 35-39, 40-49, 50-54 and 55-59 years. For each age group, the annual top five women and men were determined for both full and half marathons. For further analyses, only age groups were regarded with at least five athletes per gender and distance. For both men and women, these comprised the age groups between 20-24 and 55-59 years. These data were analyzed regarding the change of participation and performance per age group, gender and distance. The performance ratio was calculated for each age group using the equation [running time of the overall top five athletes]/[running time of the top five athletes in the respective age group] × 100. The performance ratio expresses the performance of the top five athletes of an age group as a percentage of the performance of the overall top five athletes in the respective year.

Statistical Analysis

In order to increase the reliability of data analyses, each set of data was tested for normal distribution as well as for homogeneity of variances in advance of statistical analyses. Normal distribution was tested using a D'Agostino and Pearson omnibus normality test and homogeneity of variances was tested using a Levene's test in case of two groups and with a Bartlett's test in case of more than two groups. Linear regression analyses were used to find significant changes of a variable (*i.e.* number of finishes, running speed) across years. Statistical analyses were performed using IBM SPSS Statistics (Version 19, IBM SPSS, Chicago, IL, USA) and GraphPad Prism (Version 5, GraphPad Software, La Jolla, CA, USA). Significance was accepted at $P < 0.05$ (two-sided for *t*-test). Data in the text are given as mean and standard deviation (SD).

Results

Participation Trends

From 2000 to 2010, the number of half marathoners increased linearly for both women and men (Fig. 1A). In 2010, 8,690 women and 21,583 men finished a half marathon in comparison to 2,904 female and 9,333 male finishers in 2000, respectively. This means an increase of 299% for women and of 231% for men over ten years (Fig. 1A). In contrast, a decrease in the number of finishers in a full marathon occurred since 2005 (Fig. 1B).

The greatest part of finishers of both gender was assigned to age group 40-44 years in both half and full marathons, equal to 12,216 female and 32,004 male half marathoners (Fig. 2A) and 3,377 female and 15,663 male full marathoners, respectively (Fig. 2B). More than 50% of male finishers were 40-70 years old in both full and half marathons. In half marathons, the number of finishers increased in age groups 25-29, 30-34, 35-39, 40-44, 45-49 and 55-59 years for women (Fig. 3A) and in age groups 30-34, 35-39 and 40-44 years for men (Fig. 3B). In full marathons, the number of finishers increased in all age groups for both gender except the age group 35-39 years for women (Fig. 3C) and the age groups 30-34 and 35-39 years for men (Fig. 3D).

Performance Trends

Regarding the performance of age group athletes, female half marathoners showed no change in running times in all age groups (Fig. 4A, Table 2). Male half marathoners improved running times in age groups 25-29, 35-39, and 55-59 years, whereas in age groups 30-34, 40-44 and 50-54 years, a decline in performance was recorded (Fig. 4B, Table 2). Female full

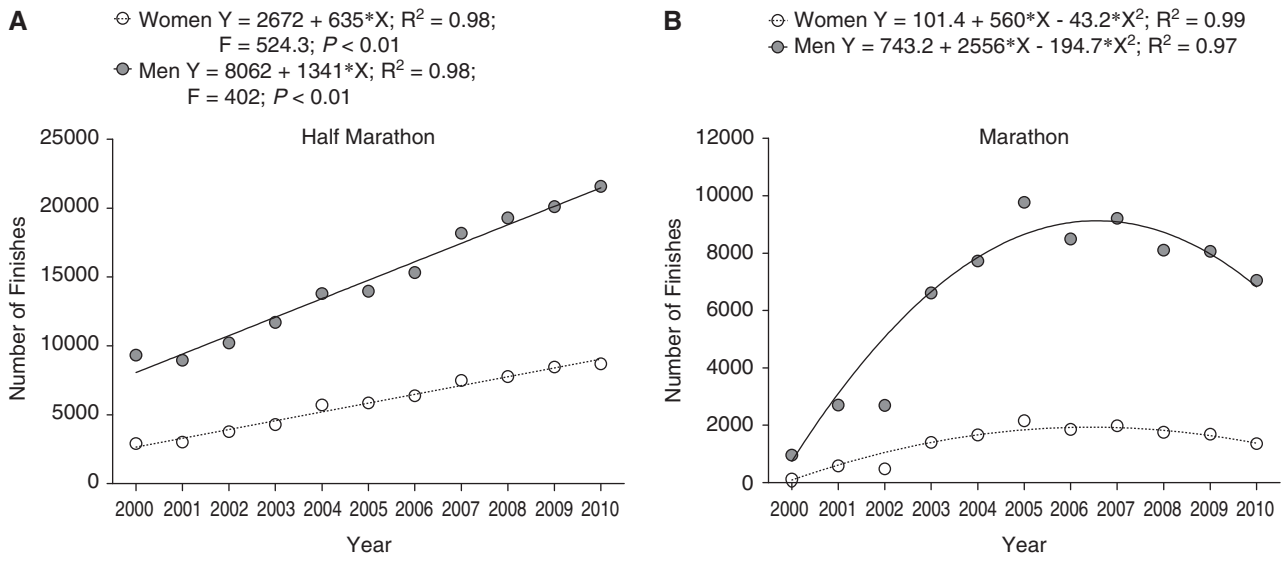

Fig. 1. Annual number of finishes in half marathons (Panel A) and full marathons (Panel B). Formulas refer to relative number of years in analysis (2000 = year 0; 2010 = year 10).

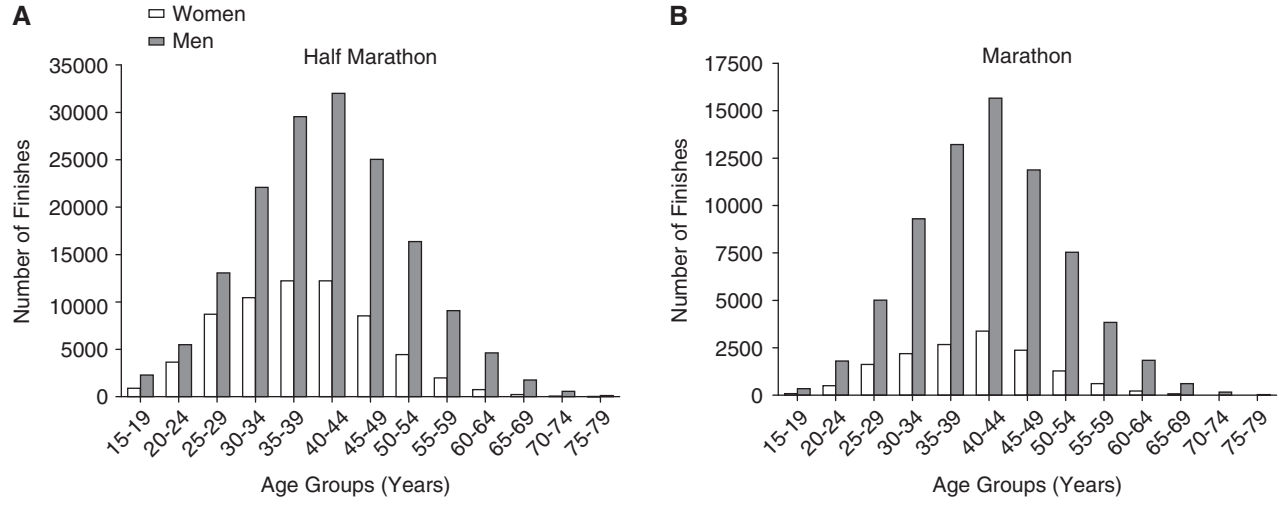

Fig. 2. Number of overall finishes per age group in half marathon (Panel A) and full marathon (Panel B).

marathoners showed a significant improvement in age groups 30-34, 35-39, 40-44, 45-49, and 50-54 years (Fig. 4C, Table 2). In age groups 25-29, 30-34, 35-39, 45-49, and 55-59 years male participants improved running times over time (Fig. 4D, Table 2).

Considering performance of age group athletes, the performance ratio showed a significant improvement for female half marathoners in age group 45-49 years (Fig. 5A, Table 3) and for male half marathoners in age group 50-54 years (Fig. 5B, Table 3). Women in age groups 30-34 and 45-49 years improved the performance ratio in marathon (Fig. 5C, Table 3). Men in age group 50-54 years showed, however, a significant decrease in the performance ratio (Fig. 5D, Table 3).

Discussion

This study investigated participation and performance trends in age group athletes competing in half and full marathons held in Switzerland between 2000 and 2010. The main findings were (*i*) an increase in participation in half marathons for both gender while participation in full marathons increased in the first five years but decreased thereafter, (*ii*) the highest number of male and female finishers was in age group 40-44 years in both full and half marathons and (*iii*) an improvement of running time for female full marathoners in age groups 30-34 to 50-54 years and in age groups 25-29, 30-34, 35-39, 45-49, and 55-59 years for men. No change

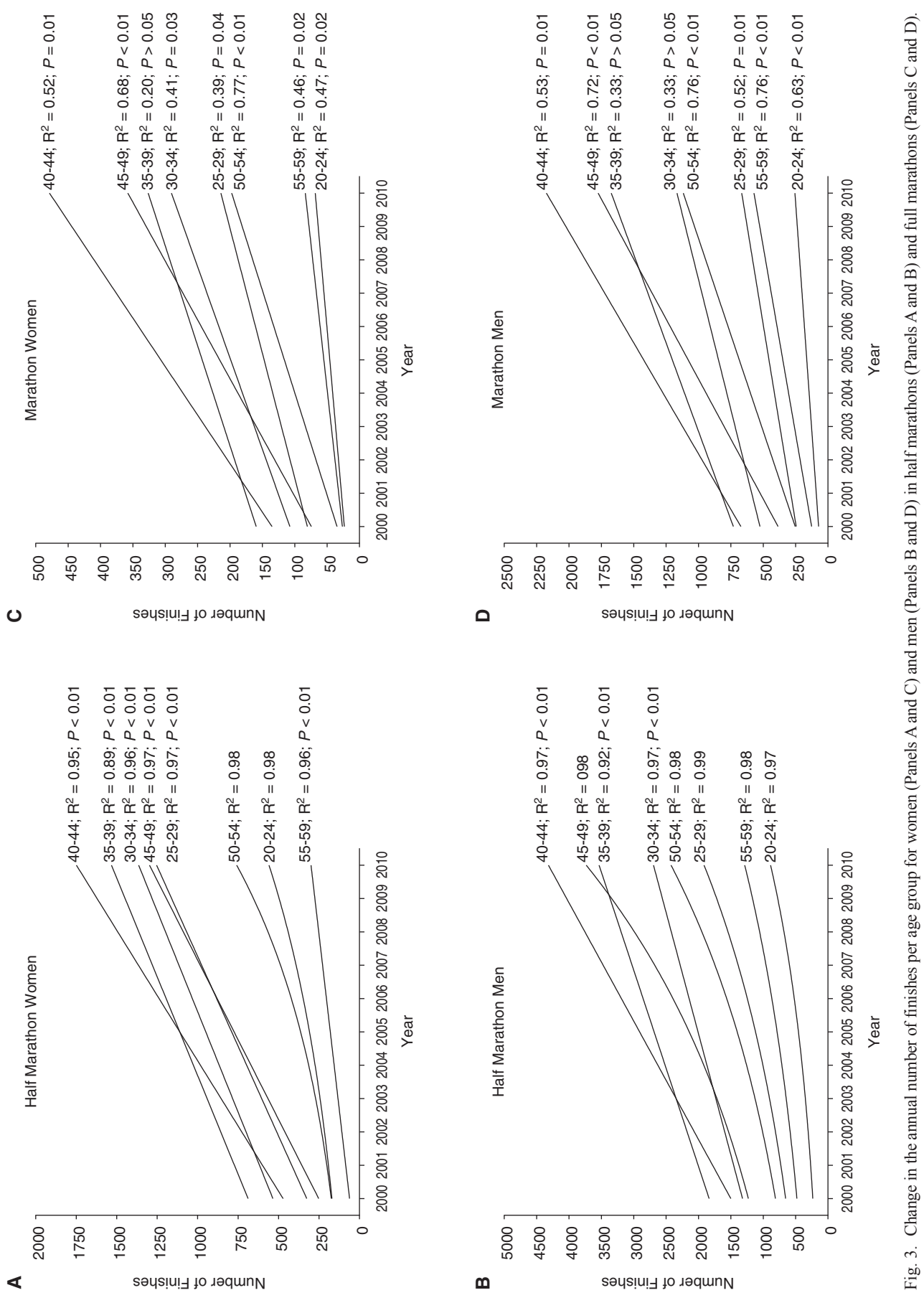

Fig. 3. Change in the annual number of finishes per age group for women (Panels A and C) and men (Panels B and D) in half marathons (Panels A and B) and full marathons (Panels C and D).

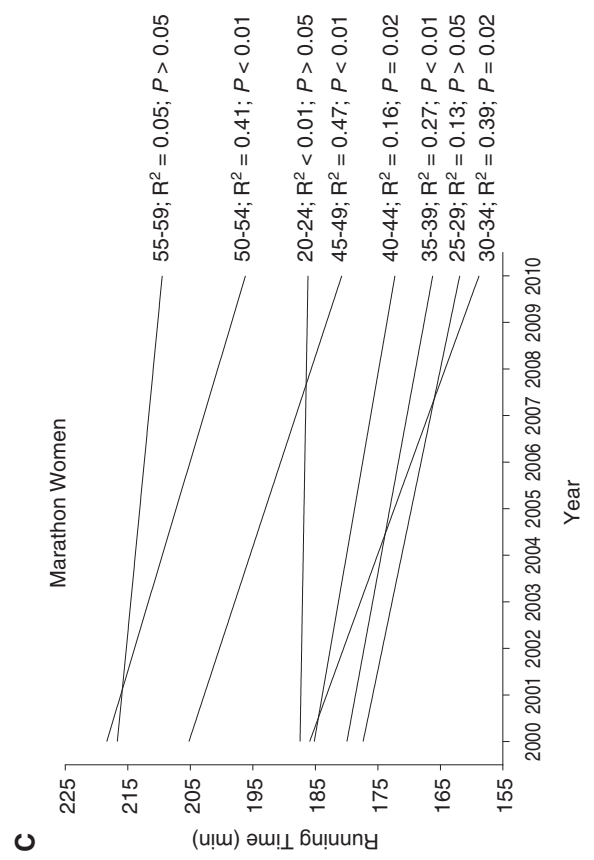

Fig. 4. Change in performance ratio for the annual top five women (Panels A and C) and men (Panels B and D) in half marathons (Panels A and B) and full marathons (Panels B and D) per age group.

Table 2. Absolute and relative change in top five running times for each age group for both half marathons and full marathons

Age group (years)	Distance	Gender	Running time in 2000 (min)	Running time in 2010 (min)	Change absolute (min)	Change (%)
20-24	half	Women	76	78	+2	+2.6
		Men	66	65	-1	-1.5
	full	Women	204	196	-4	-3.9
		Men	179	162	-17	-9.5
25-29	half	Women	81	79	-2	-2.5
		Men	66	66	±0	±0
	full	Women	195	172	-23	-11.8
		Men	158	138	-20	-12.7
30-34	half	Women	80	80	±0	±0
		Men	67	66	-1	-1.5
	full	Women	198	171	-27	-13.6
		Men	152	139	-13	-8.6
35-39	half	Women	81	78	-3	-3.7
		Men	67	67	±0	±0
	full	Women	182	168	-14	-7.7
		Men	156	141	-15	-9.6
40-44	half	Women	83	82	-1	-1.2
		Men	71	74	+3	+4.2
	full	Women	196	175	-21	-10.7
		Men	155	148	-7	-4.5
45-49	half	Women	88	83	-5	-5.7
		Men	71	75	+4	+5.6
	full	Women	217	187	-30	-13.8
		Men	165	153	-12	-7.3
50-54	half	Women	93	93	±0	±0
		Men	75	79	+4	+5.3
	full	Women	231	202	-29	-12.6
		Men	175	168	-7	-4.0
55-59	half	Women	101	97	-4	-4.0
		Men	81	82	+1	+1.2
	full	Women	225	214	-11	-4.9
		Men	182	172	-10	-5.5

in running performance was observed for female half marathoners and a decline of running time in age group athletes in 30-34, 40-44 and 50-54 years for men occurred.

Changes in Participation in Half-Marathons and Marathons

The present study showed different trends of participation for full and half marathons held in Switzerland from 2000 to 2010. Since 2005, the number of finishers decreased in full marathons whereas the participation in half marathons continuously increased. Between 2000 and 2010 more women and men finished in Switzerland a half than a full marathon. Similar findings were recorded for the USA observing a significant increase of both female and male finishers in half marathons (www.runningusa.org/statistics). In contrast to the present findings, the number of full marathoners increased in the USA as well, but the number of participants differed between the two distances (www.runningusa.org/statistics).

Although an increase in the annual participation could be detected for both full and half marathons held in the USA, the increase in participation in full marathons was lesser than in half marathons. In 2011, a total of 518,000 runners successfully finished a full marathon in the USA, which amounts to an increase

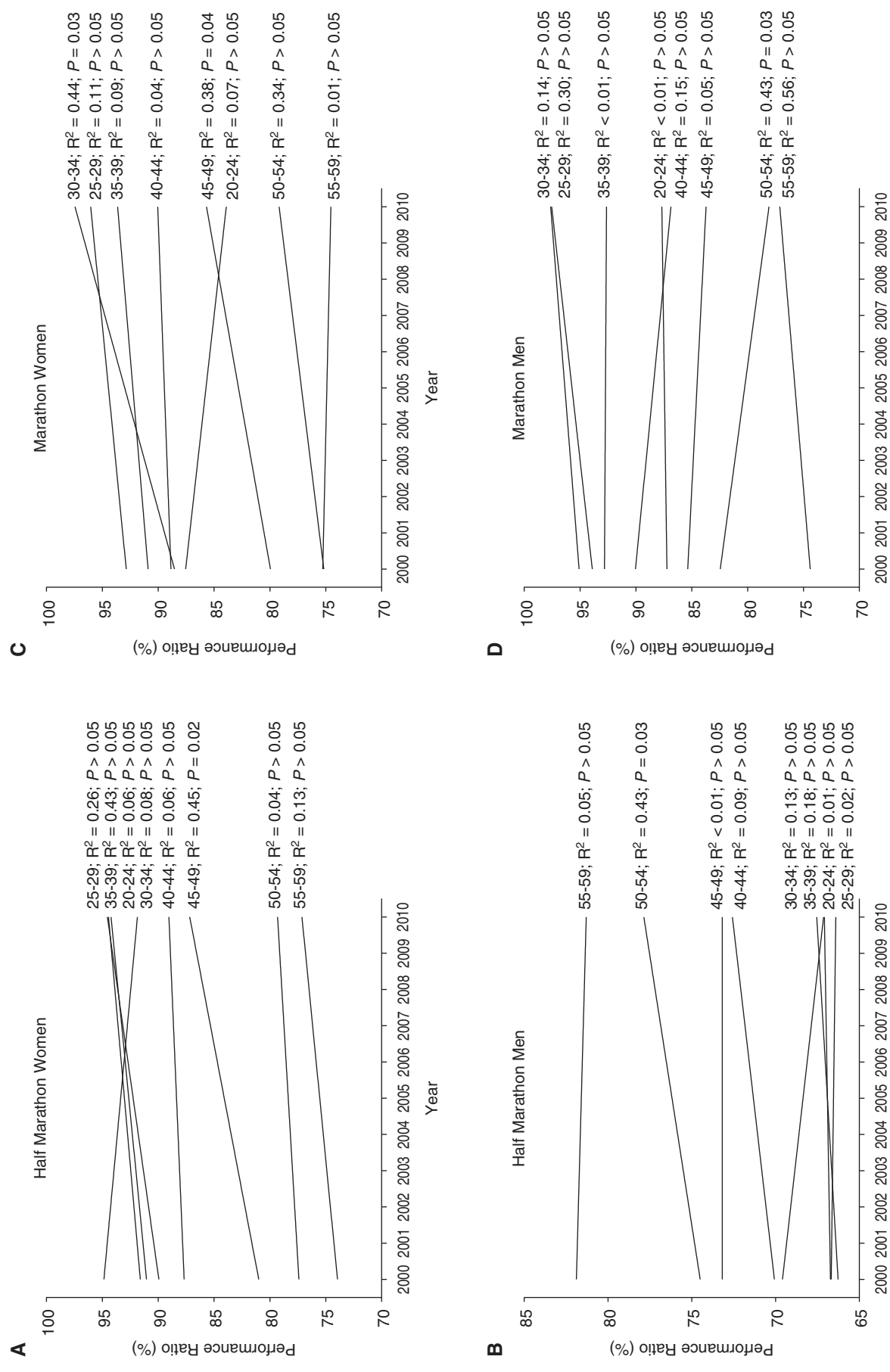

Fig. 5. Change in performance ratio for the annual top five women (Panels A and C) and men (Panels B and D) in half marathons (Panels A and B) and full marathons (Panels B and D) per age group.

Table 3. Change in performance ratio for each age group and distance for both half marathons and full marathons

Age group (years)	Distance	Gender	Performance Ratio in 2000 (%)	Performance Ratio in 2010 (%)	Change (%)
20-24	half	Women	97	95	-2
		Men	96	97	+1
	full	Women	85	82	-3
		Men	82	82	±0
25-29	half	Women	91	94	+3
		Men	96	96	±0
	full	Women	89	94	+5
		Men	93	96	+3
30-34	half	Women	92	93	+1
		Men	94	95	+1
	full	Women	88	95	+7
		Men	96	96	±0
35-39	half	Women	91	95	+4
		Men	95	95	±0
	full	Women	95	96	+1
		Men	94	94	±0
40-44	half	Women	89	90	+1
		Men	90	85	-5
	full	Women	89	92	+3
		Men	95	90	-5
45-49	half	Women	83	89	+6
		Men	90	84	-6
	full	Women	80	86	+6
		Men	89	87	-2
50-54	half	Women	79	80	+1
		Men	85	80	-5
	full	Women	75	80	+5
		Men	84	79	-5
55-59	half	Women	73	76	+3
		Men	79	78	-1
	full	Women	77	76	-1
		Men	81	77	-4

of 2.2% compared to 2010. The number of 1,610,000 athletes participating in a half marathon instead means an increase of 16.2% compared with the year before (www.runningusa.org/statistics). By comparison, in Germany, the number of participants in full marathons continuously increased until 2006 and decreased slowly afterwards (www.marathon-bestenliste.de).

Supporting arguments for the greater increase in half marathoners might be that recreational runners may start their running career with a half marathon and after some years of training and competing start to run a full marathon (35). Improved performance in a half marathon could be achieved after shorter training periods since recent findings showed that the intensity of running speed during training was related to half marathon race times (26). Half marathons and shorter distance competitions might therefore be more attractive for less ambitious runners and beginners, while several factors are important for finishing a long-distance run successfully (26). For example, both a low body fat and a fast running speed during training close to race pace were reported as key variables for a fast full marathon race time in recreational male runners (3). In general, a regular running training and a moderate way of life were required to finish both full and half marathons successfully by both professional and recreational runners (5, 17, 20, 23). Frequency, intensity and volume of the training units are essential for improving performances in long-distance races (2, 11, 12, 18).

Highest Number of Finishers in the Age Group 40-44 Years

The highest number of finishers in both half and full marathons was found in the age group 40-44 years for both women and men. Similarly, a German study showed that most of the full marathoners were competing in the age groups 35-54 years (22). In Switzerland, the percentage of athletes younger than 39 years in half marathons and 44 years in full marathons was higher among women compared to men. However, more than 50% of male finishers were between 40 and 70 years old in both full and half marathons. This effect would also be present if no new young athletes started to participate (4). Leyk *et al*. (23) reported that a high number of athletes started with running after reaching the age of 40 years. The older the runners the more they participated in long-distance competitions (30). Compared to long-distance running competitions like ultra-marathon some parallel aspects can be found. Knechtle *et al*. (19) and Hoffmann and Wegelin (15) reported that most of the male and female participants in ultra-marathons were 40 to 49 years old. In ultra-marathons, the age-relating distribution was explained by a decrease of younger finishers parallel to an increase of older ones (19).

Improvement of Running Performance in Older Age Groups

Considering the performance of top-five full marathoners in age group athletes, a significant improvement of running times was found for athletes in age groups 30-34, 35-39, 40-44, 45-49, and 50-54 years for women and in age groups 25-29, 30-34, 35-39, 45-49, and 55-59 years for men. No significant change of performances occurred for male full marathoners in age groups 40-44 and 50-54 years. However, no similar development was found in half marathons and especially no improvement or even a decline of running times was found for half marathoners. Assumedly, the constant increase of half marathon finishers is due to newcomers. These newcomers usually show worse performances than habitual runners. This could be an explanation for the lack of improvement of running times for years in half marathons.

The youngest age group showed the best performance ratio in both full and half marathons. Analyses at the 'New York City Marathon' showed constant running times at an age between 20 and 40 years (16). Half and full marathoners showed differences concerning anthropometry and training types but also similarities influencing running times (35). For example, full marathoners completed 1.2 times more training units than half marathoners and invested 1.2 times more time in training (35). This probably explains the less distinctive improvement of running times in half marathons for men and the lack of improvement of running times for women in Switzerland during the years studied. Marathoners completing more training kilometres were faster at the race (11, 12, 14, 34). The running speed during training was related to race time for recreational half marathoners and recreational full marathoners (28, 35). Professional long-distance runners were older, lighter and smaller compared to finishers at middle and short distances (1). For ultra-marathons, the fastest race times were observed for athletes at an age between 30 and 49 years for men and between 30 and 54 years for women, respectively (19). Schulz and Curnow (29) postulated that fast running times were associated with an older age of the finishers in long-distance competitions.

Limitations

A limitation of this study was the lack of evaluation of environmental conditions such as ambient temperature (9, 10). In addition, this study lacks data about physiological parameters (24, 33) and the anthropometry of the finishers (35). Nutrition was also not considered as a variable that might influence running times (7) as well as electrolyte changes like exercise-associated hyponatremia and fluid intake (8, 25). The inclusion of all these variables might also have had an impact on the results presented in this study.

Conclusion

The number of half marathoners increased in Switzerland from 2000 to 2010 in contrast to a decrease in the number of full marathoners after 2005. The greatest part of male and female finishers belonged to the age group 40-44 years for both half marathoners and full marathoners. During the 2000-2010 period, it appeared that participation in half marathons in Switzerland increased but running performance stabilized. In contrast, participation in full marathons decreased but running performance improved. Further investigations concerning half and full marathons in other countries during a defined period of time are required to collect more data to confirm our results for participation and performance trends in different age groups. Furthermore, other endurance events in Switzerland should be investigated in comparison to our results.

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